Propagation of GPS Signals as Wave Packets During ionospheric Storms

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We study the propagation of a vector wave packet in the ionospheric medium. The large scale deviations of an ionospheric parameter from its monthly median, average, or otherwise "typical" behavior have traditionally been referred to as ionospheric storms. By using the superposition principle and Fourier transform theory a general formulation of wave propagation theory is developed. By further analysis we obtain the ionospheric transfer function involving the rise time, which is a realistic measure of the shortest usable pulse length in communication. We prove that the square magnitude of the complex amplitude of the wave packet over the whole space integrates to a constant if the medium is lossless. The first moment determines the position vector of the centroid of the wave packet and is a nonlinear function of time. 'l-bus the concept of group velocity is extended to widebanded wave packets.

We apply our results to ten storms by using the measurements of electron content of the midlatitude F-region and the L1 band. We calculate the second moment of the wave packet that reflects the anisotropic nature of the propagating medium and reveals the pulse shape distortion introduced by the ionospheric storm.

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